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低渗致密气藏压裂水平井产能预测新方法

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A New Method for Predicting Productivity of Fractured Horizontal Wells in Low-permeability Tight Gas Reservoir

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摘要/Abstract

摘要 :

应用位势理论、叠加原理和流体力学的相关原理,建立了考虑裂缝干扰、污染表皮、裂缝非均匀分布、裂缝与井筒有限导流,以及裂缝—井筒汇聚流、裂缝内高速非达西流动的压裂水平井稳态流动数学模型,给出了模型的数值求解方法,并运用模型预测了实际水平井产能,分析了产能的影响因素。结果表明,该模型适用性强,能用于各种复杂情况下的水平井产能预测,预测精度较高;由于裂缝间的干扰作用,各条裂缝产量存在差异,水平井筒两端裂缝产量高,中间裂缝产量低;水平井产能随水平段长度、裂缝半长、裂缝导流能力的增大而增大;裂缝污染表皮对产能影响显著,产能随表皮系数的增加而急剧下降,因此应尽量减少压裂作业对地层的伤害;在相对合理裂缝间距范围内,裂缝分布形式对产能影响不明显;井筒半径对井筒压降有影响,应根据水平井产能的高低,设计合理的井筒半径。

关键词: 低渗致密气藏, 压裂水平井, 裂缝, 井筒, 产能, 影响因素

Abstract:

Adopting potential theory,the superposition principle and the related principle of fluid mechanics,a steady mathematical model for fractured horizontal well is established considering interactive disturbance among fractures,pollution skin,non-uniform distribution of fracture,finite conductivity flow in fracture and wellbore,and fracture-wellbore convergent flows,non-Darcy flow in fracture.Then the numerical solution to the model is derived.The model is applied to predict an actual productivity of horizontal wells and to analyze the influence factors of productivity.Result shows that the model can be used for horizontal well productivity prediction with various complicated situations and it shows high accuracy.Due to the fracture's mutual interference,the production rate of fracture differs.Fractures on both ends of the horizontal wellbore have high yield,while fractures in middle have low yield.Horizontal well productivity increases with the growth of horizontal interval length,fracture half-length,and fracture conductivity.Pollution skin of fracture has significant effects on productivity.The increase of it leads to a sharp decline of productivity.Thus it is important to reduce the damage of fracturing operation on formation as much as possible.Within relatively reasonable fracture spacing scope,the effect of fracture distribution pattern on productivity is not obvious.Since wellbore radius affects wellbore pressure drop,its design should be in accordance with the productivity of the horizontal wells.

Key words: Low-permeability tight gas reservoir, Fractured horizontal wells, Fracture, Wellbore, Productivity, Influencing factors

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